Asarco: The Metal Maker

1975

INTRODUCTION

Just before the turn of the century, the nonferrous metals industry in the United States was in trouble. Many lead-silver smelters were being crushed under a heavy burden of low prices, excess capacity, labor troubles, and increasingly complex ores. The mines, which contributed so much to the early settling of the American frontier, also faced problems. As the smelters went under, mining companies were faced with the prospect of either having to close up or build their own smelters; and the country could hardly afford to lose the output of metals so essential to the nation's growth.

The American Smelting and Refining Company (Asarco) was organized in 1899 to meet this impending crisis. Originally a consolidation of a number of lead-silver smelting companies, the Company has evolved over the years into an integrated miner, smelter and refiner of copper, lead, zinc, silver, and a host of by-product metals. Asarco's expertise in exploration and mining has also led to expansion into related fields such as the mining of coal, asbestos, ilmenite (a titanium-bearing mineral), sand, gravel, and limestone.

The original purpose of the Company, however, remains an important part of Asarco's operations today: custom smelting and refining ores mined by others. This is an important service to many mining operations too small to support their own smelters but whose combined output represents a significant domestic supply of metals. The metallurgical sophistication of its smelters makes Asarco the only U.S. firm capable of processing certain complex ores and recovering such valuable by-products as bismuth and arsenic trioxide.

Since its founding, Asarco's refineries have produced more than 26 million tons of copper, enough to make a household size wire that could be strung 26,000 times around the world; 26 million tons of lead, enough to make 2.5 billion automobile batteries; approximately seven million tons of zinc, which would coat and protect from corrosion a highway guard rail long enough to cross the U.S. 1400 times; and over six billion troy ounces of silver, enough to mint eight billion silver dollars. Some of this metal originated from Asarco's own mines, but more came from the mines of others, and from the mines of Asarco's associated companies in other countries.

Metal must be mined where it is found. Almost since its inception Asarco has been involved in mining ventures outside the U.S. Today it has a significant interest in three of the world's great mining companies: Asarco Mexicana, S.A.; Southern Peru Copper Corporation; and M.I.M. Holdings Limited in Australia. Additionally, it operates other mines in Canada, Nicaragua, and Peru.

An increasingly important source of metal in the world is the scrap generated by metalworking operations or recovered from obsolescent automobiles, appliances, and other metal goods. The Federated Metals Division of Asarco is a major U.S. recycler of scrap metal, converting it into copper, lead, and zinc alloys for a multitude of uses.

This, then, is Asarco, a company which extracts vital raw materials from the earth and converts them along with those extracted by others into metals and minerals useful to mankind. How Asarco does this, and has been doing it for all the years of this twentieth century, is told in the following pages.

ASARCO OPERATIONS

Asarco the explorer

Mining starts with exploration. A mining company must continually find new ore bodies or eventually go out of business. Discovery is a rare event, however, and then it may be many years before a find can be developed into a profitable, operating mine.

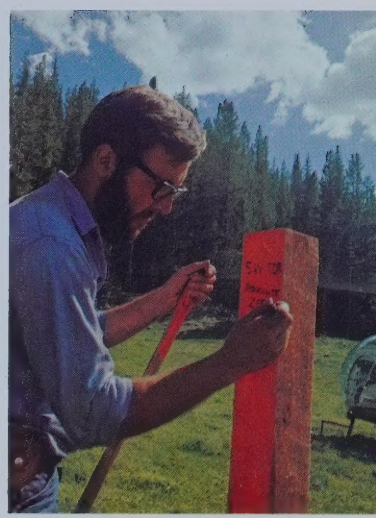
Exploration has come a long way since the time when two prospectors got so inebriated on a bottle of whiskey that they dug a hole on the very spot where they were imbibing and uncovered great riches. Their discovery in Colorado's mountains was to become the Little Pittsburgh silver mine on Fryer Hill, which for many years shipped ore to Asarco's Arkansas Valley smelter in Leadville.

In those early days of the silver and gold rushes, the fantasies of riches and high living drove men to sell their homes, their souls, and in many cases their sanity in order to strike paydirt. Today, the methods and means of exploration have become more sophisticated, but the object remains the same: to find valuable mineral deposits. In the case of Asarco's exploration department, attention is focused primarily on nonferrous metals, asbestos, stone, coal, and ilmenite.

Where does Asarco look for minerals? According to an adage, if you want to find elephants, go to elephant country. Thus, if copper is your quest . . . In many instances the general geology suggests potential mineral belts. An example of this is the almost continuous series of mountain ranges which run along the west coast of North, Central, and South America, marked throughout by deep faults and massive intrusions of once-molten rock. Today many copper mines are being worked along this belt from Alaska to Chile.

Careful and patient studies of the surface geology often provide obscure clues to possible hidden minerals. To aid these studies, Asarco in some cases employs geophysical and geochemical techniques to explore an area. One geophysical procedure involves sending electric impulses into the earth and then recording and evaluating the data received from these impulses. Geochemical exploration entails analysis of soil, stream sediment, rock chips, and similar materials for minute traces of metals and associated elements. In many instances the location and terrain may require that Asarco's explorers be experienced woodsmen, rock climbers, jungle travelers, or desert dwellers.

Consider the exploration story of Asarco's Mission Mine in Arizona. In 1950 Asarco's geologists became familiar with a small mine southwest of Tucson. The area north of the mine was unclaimed and thought to



licopter puts once-inaccessible tcrops within reach of Asarco plorer about to do some geologic apping (left). An Asarco explorer ght) marking a potential mineral posit.

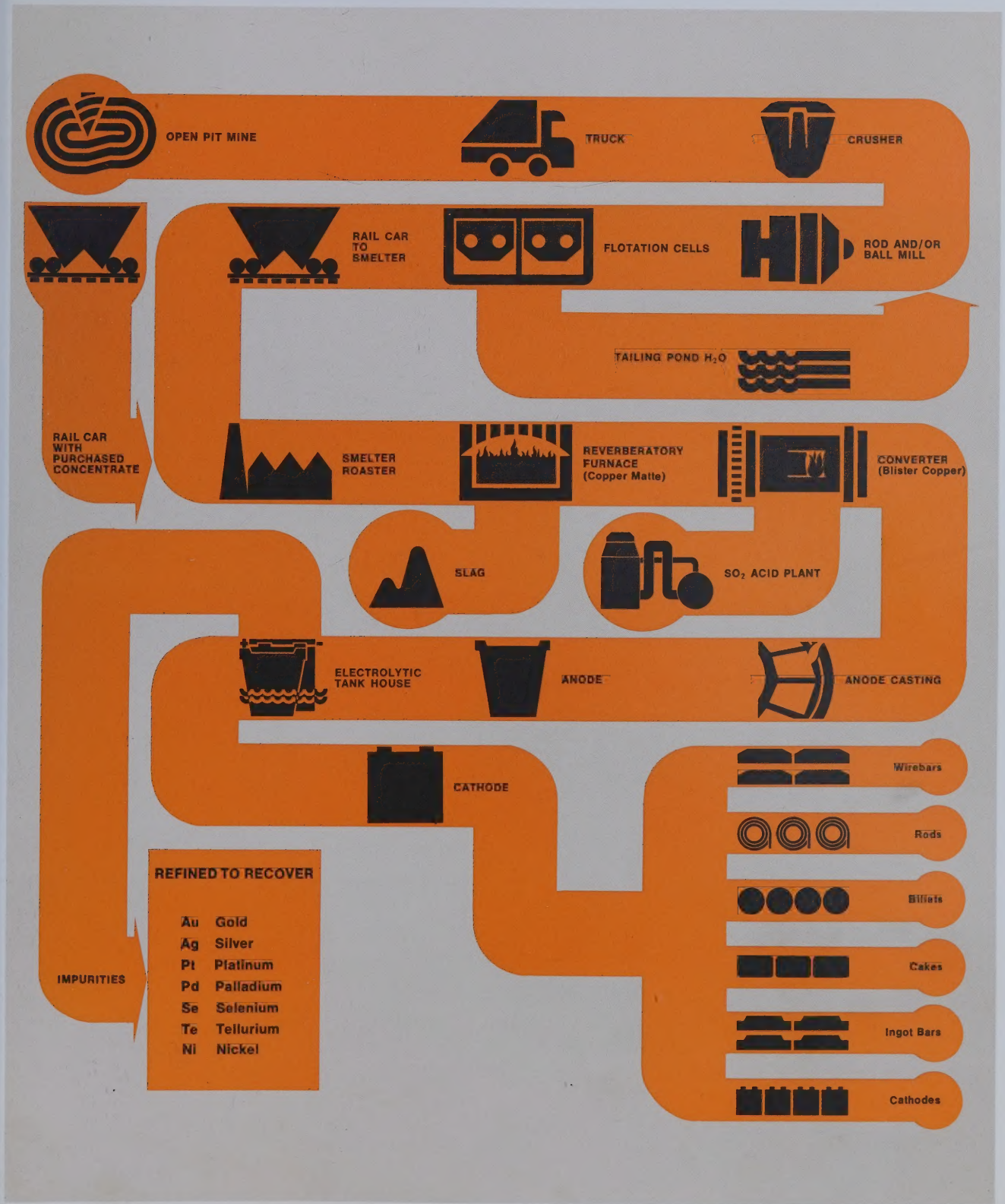
be devoid of anything but sand, gravel, cactus, and sagebrush. However, one small hill in the distance caught the attention of Asarco's team, which recognized it as being favorable, well-altered rock. A group of claims were staked by Asarco, but the initial drilling turned up no ore. Nevertheless, the drill samples showed encouraging geology; geophysical surveys were undertaken and drilling commenced again. Still no good ore, but enough money was left in the appropriation for one more drill hole. Paydirt!

More was needed, however, than just finding the ore body. It had to be drilled out, and tonnage and grade had to be carefully calculated. Nearly 3500 acres of adjacent land was required for a mill site, tailings pond, and waste rock dumps. Acquiring this land, plus rights to drill water wells in the valley, took years of negotiations with ranchers and with the Papago Indian tribe into whose reservation the ore zone extended. Still, the end result has been Asarco's biggest wholly-owned copper mine.

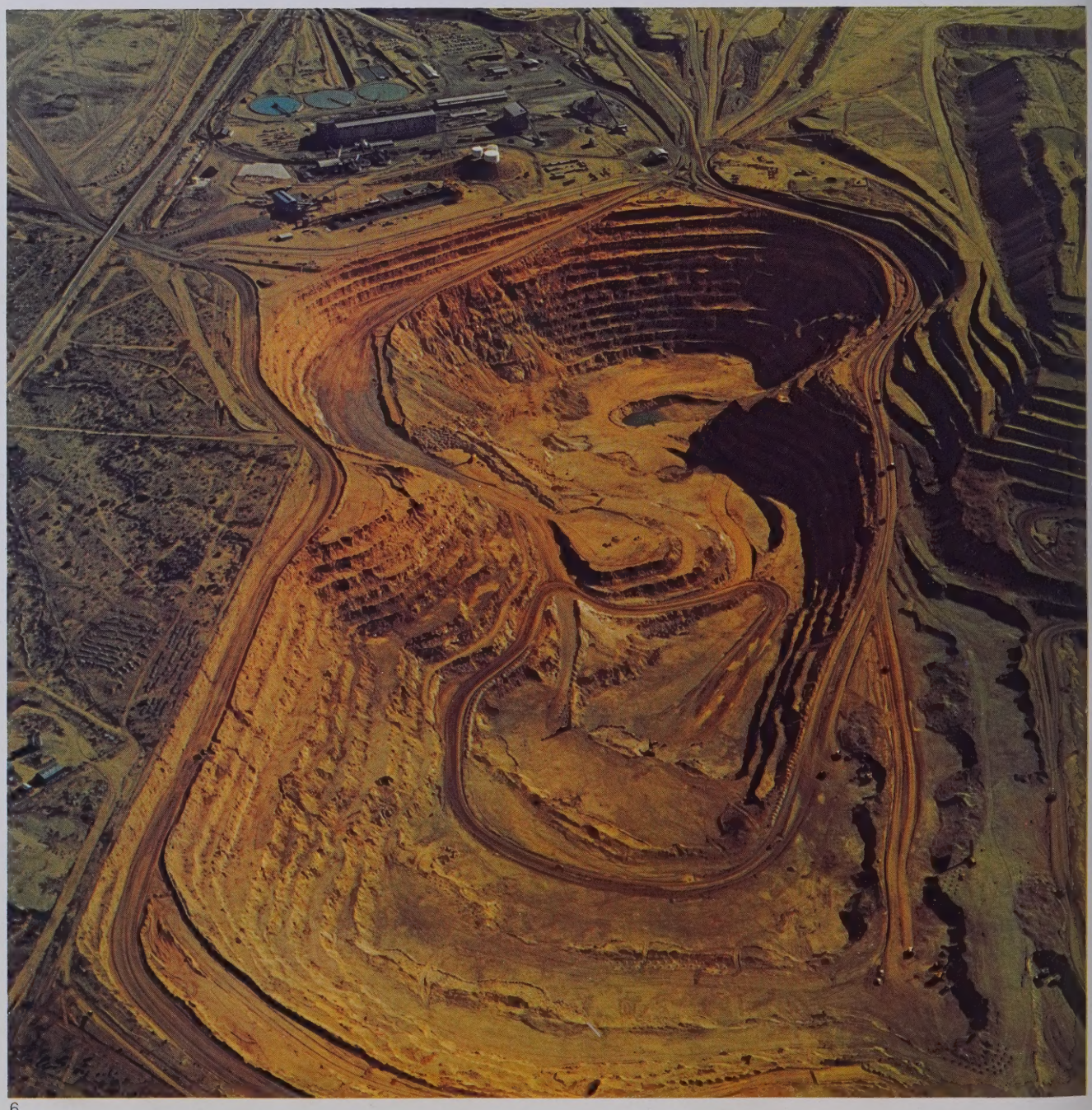
This is what exploration is all about. Thousands of prospects have been examined by Asarco since the early 1920's—more than 2,000 alone in the years 1961 to 1971. Only a few have actually "panned out", but that's the way it has always been in the mining industry. Even so, the long-term fortunes of Asarco will be determined to a very great degree by the success of its exploration.

Core samples from drill are checked by explorers. From the field these samples are then sent to a regional office for analysis.

Copper-from mine to metal



Asarco the miner



Mining has been an increasingly important part of Asarco's operations since the early days of the Company. This does not appear in the name "American Smelting and Refining Company" only because mining was a relatively small activity of the original company. However, during the ensuing 75 years, Asarco has expanded its interests until as much as 75% of the Company's annual earnings before taxes have come from mining (including mining by the associated companies outside the U.S.).

While mining today is an exact technical science, one can still sense the color and excitement of mining history and tradition in such places as Leadville, Colorado, and Wallace, Idaho, where two of Asarco's mines are located.

At Leadville, mining has always been king. An off-shoot of the great California gold rush, this area became synonymous with mining in the 19th century and, along with California and Nevada, stimulated development of the entire West. Denver blossomed into a city following mineral strikes at Leadville and elsewhere in Colorado.

Leadville is also where the Guggenheims, who played an important role in the early development of Asarco, first entered the mining business. Asarco still operates an underground lead-zinc-silver mine in the area.

The interest in mining stimulated at Leadville spread to the Wallace area in the late 19th century. Located in the Coeur d'Alene mountains in northern Idaho, Wallace today is a blend of modern mining life and the historical flavor of earlier times. Remnants of old mining camps and mines can still be seen in the area, and mining lore is a favorite topic of conversation among old timers as well as visitors in Wallace.

Local residents refer to Wallace as the "silver capital of the world" with good reason, since nearly half of all the silver mined in the United States comes from this small region. There Asarco operates the second largest U.S. silver mine, the Galena, and is actively exploring another property nearby through underground workings. Yearly, the ore extracted from Galena yields approximately four million ounces of silver.

At Galena, miners descend two shafts 4,450 feet and 5,120 feet deep to mine the relatively narrow veins. Throughout the day these miners work to extract and load ore which has been exposed and loosened by blasting done at the close of the previous work shift. Additionally, they prepare for more blasting which will set up the ore for the next shift. Blasting takes place only after the miners have completed their work shift and have ascended the shafts. The ore is hoisted up the shafts and concentrated at the mill adjacent to the mine. The concentrates enter the Asarco smelting circuit after shipment to the El Paso, Texas, or East Helena, Montana, plants.

Copper, more than any other single metal, makes Asarco a leading mining company. Three smelters and three refineries in the Asarco metallurgical complex in the United States process the valuable "red metal". Because of Asarco's commitment to copper production, the Company has made a major effort over the past two decades to acquire ore reserves of the metal it has smelted and refined since nearly the beginning of the century.

Asarco's present U.S. copper mines are largely concentrated in Arizona, "the cop-

ıe Mission open-pit copper mine
ıar Tucson, Arizona.

per state" which accounts for more than half of the total annual U.S. copper mine output.

Asarco's first important copper mine in Arizona was developed at Silver Bell, northwest of Tucson. Natives of the area offer a variety of reasons when asked how their mining town got its unusual name, since silver mining has never been important in the area. Some say the name comes from a certain flower in the region. Others claim it was named for Belle Caruthers who, in the 1850's, was often seen in town riding a silver horse. The most popular tale is that there was once a dance hall girl named Belle; when she grew older and her hair turned grey they called her Silver Belle and named the town after her.

The Silver Bell area has been mined for well over 100 years; Indians were mining there even before the white man came to the territory. The early miners used hand tools. The first "ore cars" probably held only a fraction of a ton; today, ore trucks at Silver Bell can haul 85 tons apiece. Development of the Silver Bell copper deposits began on what was called the Mammoth Lode in 1873.

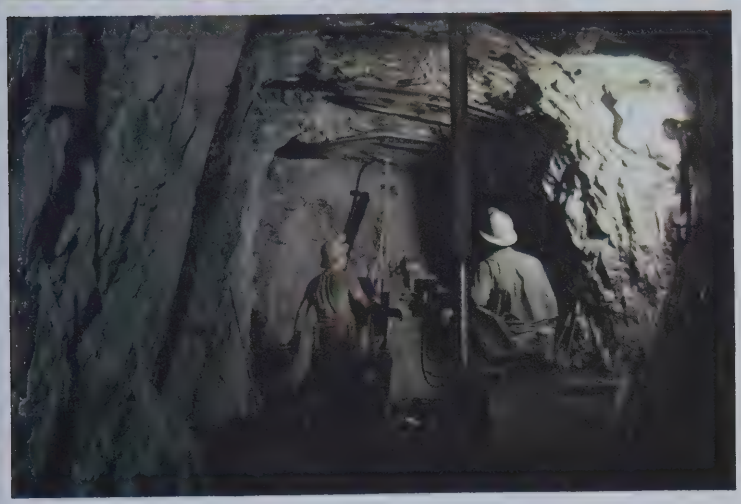
Asarco's current operations at Silver Bell are two porphyry copper open pits, the El Tiro and the Oxide. Ore from both pits is hauled in trucks to a primary crusher, then on conveyor belts through secondary and tertiary crushing equipment, and into the mill for concentrating. Current milling capacity is about 11,000 tons of ore per day. Nearly all of Silver Bell's copper output is shipped to Asarco's nearby Hayden, Arizona, smelter for further processing into blister copper ready for refining.

The Mission Unit is Asarco's largest mining property, and is located near the famous Mission San Xavier del Bac, southwest of Tucson. The mine takes its name from this mission which was built in the 1700's to honor Father Kino, an early Spanish missionary.

In 1967 the capacity of the mill at Mission was increased from 15,000 tons of ore per day to 22,500 tons. In recent years, Mission's production has topped 180,000 tons of concentrate per year, grading about 28% copper. In addition, a molybdenite plant was built in 1964, enabling the Mission Unit to produce about 1,000 tons per year of molybdenite concentrate. Virtually all of Mission's copper output is smelted at the Hayden smelter.

Mining copper ore from Mission, Silver Bell, or from any other open-pit deposit for that matter, is not as simple as just loading rocks into trucks. First and foremost, the mine's pit supervisors and shovel operators have to be trained to differentiate the ore from the barren rock. These men are aided by assay maps prepared by the pit engineers from assays of samples from holes which have been drilled in the mine. Part of their job is classifying the ore which varies in copper content and hardness of rock. The ore must be mined selectively because of these variations, and then blended for maximum recovery of metal content in the mill.

Open-pit mines are designed in "benches" (resembling a large circular stairway) in order to allow more selective mining and easy transporting of the ore. Explosives are used to loosen the ore from the benches. Large electric shovels then



(Above) Set high in Colorado's Rockies is the Leadville Unit, managed by Asarco and owned jointly with Newmont Mining Corp. (Below) Miners at Galena mine in Idaho's Silver Belt preparing a silver ore vein for blasting.

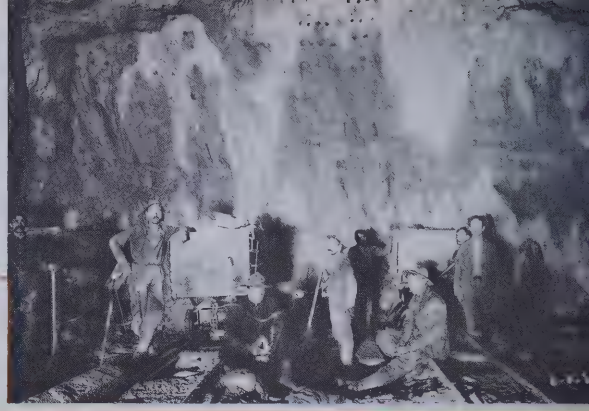
ASARCO MINING HISTORY HIGHLIGHTS

1899—Asarco organized. Included in original consolidation were mines and mining claims in Colorado and Mexico.

1900-1909—Merged with M. Guggenheim's Sons.
Purchased control of Federal Mining and Smelting Company, which owned mining properties in Idaho.

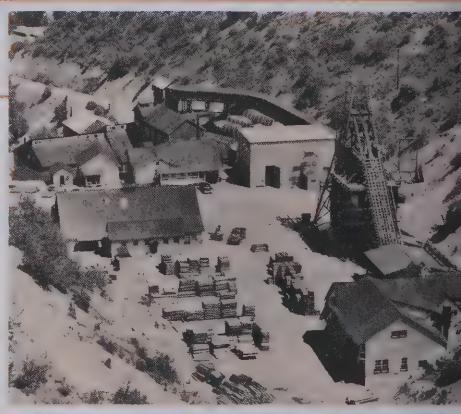
Acquired five additional mines in Mexico.

1910-1919—Purchased mining properties in Silver Bell district of Arizona.



1920-1929—Page mine in Idaho started up.

Northern Peru Mining and Smelting Company organized.
Buchans mine in Newfoundland brought into production.
Ground Hog mine in New Mexico opened.



1930-1939—Initial investment made in Australia's Mount Isa Mines Limited (see p. 31).
Acquired interest in Neptune Gold Mining Company in Nicaragua (see p. 36).

1950-1959—Production commenced at Silver Bell, Asarco's first open-pit mine.
Galena silver mine in Idaho started production.

Lake Asbestos of Quebec, Ltd. began operations (see p. 38).

1960-1969—Southern Peru Copper Corporation opened Toquepala mine (see p. 32).
Mission mine in Arizona started up.

Mexican mines and plants organized into Asarco Mexicana, S.A. (see p. 32).
Page mine closed.

1970-1974—Granduc copper mine in British Columbia commenced operations (see p. 36).
Midland Coal Company Division formed from four purchased Illinois mines (see p. 38).
Leadville mine in Colorado began mining lead-zinc-silver ore.
Four Tennessee zinc mines purchased.
American Limestone Company of Knoxville, Tennessee, acquired (see p. 39).
San Xavier copper mine and leach plant in Arizona started production.
Manchester ilmenite mine in New Jersey started up (see p. 39).
A partnership of Anaconda and Asarco began development of Ontario lead-zinc-silver mine in Utah with production slated for 1975.
Copper mining began at Sacaton open pit in Arizona.

load the ore into haulage trucks which dump into a primary crusher near the mill.

The primary crusher breaks up the ore, which can sometimes be in rocks as large as four feet in diameter, into more manageable sizes, usually less than five or six inches. From the primary crusher the ore is conveyed to secondary and tertiary crushers where the rocks are reduced to sizes ranging from one half inch to about three quarters of an inch in diameter, depending upon the mill's specifications.

After crushing, the ore is mixed with water and ground to fine sand-like pulp in a circuit with rod mills and ball mills. The pulp then goes into a cell flotation circuit where reagents are added to the pulp mixture and more than 90% of the copper metal content floats to the top and clings to the froth. The froth is then collected and dried, and the resulting concentrate containing nearly 30% copper is shipped to a smelter to be converted into blister or anode copper.

An alternative way of treating open-pit copper ores that are basically oxide rather than sulfide is through acid leaching. Asarco employs this method at a newly-constructed facility near the Mission Unit. This plant leaches copper oxide ore from the new San Xavier mine, and has the capacity to produce about 15,000 tons per year of precipitates with an average copper content of 80-82%. Some copper is also recovered by leaching of the "waste" dumps at Silver Bell.

In the leaching process at San Xavier, crushed ore is fed into large vats and subjected to a six-day leaching period using sulfuric acid produced at the Hayden smelter. At full operation the plant consumes fifty thousand tons of acid each year. Copper dissolved in the solution is then precipitated with shredded "tin cans"

or other iron scrap and shipped to the Hayden or El Paso smelters for reduction to blister copper.

Asarco's newest copper mine, the Sacaton open-pit mine and mill near Casa Grande, Arizona, started production early in 1974. It has an annual capacity of 21,000 tons of copper contained in concentrates, boosting the Company's domestic mine capacity to over 100,000 tons of copper per year. Asarco expects to mine a second, deeper ore body at Sacaton by underground methods starting in 1979.

Asarco's other mines include the Quiruvilca Unit in Northern Peru, a copper mine operated by the wholly-owned Northern Peru Mining Corporation; the Buchans Unit in Newfoundland, Canada, and the Ground Hog Unit at Vanadium, New Mexico, both of which mine lead-zinc-silver ores; and four zinc mines in Tennessee, purchased in 1971 from the American Zinc Company.

The ores in the Tennessee zinc mines, located near Knoxville, are used chiefly in the production of zinc oxide at Asarco plants in Hillsboro, Illinois, and Columbus, Ohio, which were also purchased from American Zinc. The Tennessee zinc mines contain large, though low-grade, ore bodies (in contrast to the relatively narrow veins in Western lead-zinc or silver mines). The total estimated reserves at the four mines—the Immel, Coy, Young, and New Market—are more than 77 million tons of ore averaging 3 to 4 percent zinc.

Zinc ores from the Immel, Young, and Coy mines are concentrated at the Company's Mascot mill located near the Immel mine, while the New Market mine has its own mill. A larger and more modern mill is being constructed to replace the Mascot mill and should be completed in 1975.

Ore is hoisted automatically from Immel Mine (left). Hoist is located inside housing atop square headframe. (Right) Unloading concentrates for smelting.

Asarco the ore buyer

Asarco's ore purchasing department is responsible for maintaining the supply of mineral raw materials from which the Company produces and markets metals. Throughout the Company's history, ore buying has been vital to Asarco's operations. As Asarco has expanded its mining and international operations, the ore department has become both a buyer and seller in international markets of ores, concentrates, precipitates, crude products containing precious metals, blister copper, residues and secondary materials.

The ore purchasing department buys metal-bearing materials for the Company's processing plants both from Asarco's own mines and from independent mining companies, thereby providing a valuable outlet for the ores of domestic and foreign mining companies which lack facilities to smelt their own mine output. In some cases mining companies that have been able to develop sizable ore reserves because Asarco helped provide a market for their products initially are now operating their own smelters and refineries.

In purchasing materials from independent mining companies or from Asarco's own mines, the department arranges payment based on published prices for the contained metals less agreed charges for processing. Asarco then assumes the processing and selling costs and the market risks. Its profits from smelting and refining are derived from its realized price for the metals less the amount paid for raw materials and processing and delivery costs.

Prices of nonferrous metals fluctuate in both the United States and international markets in response to local and international supply and demand conditions or, at times, to government price controls. Ore buyers at Asarco must study and evaluate all long-range market developments so that the Company may remain competitive with other smelters in purchasing materials. Also, concentrate intake at the smelters and refineries must be related to anticipated sales volume.

Asarco's ore buyers must be knowledgeable about the metallurgy at the Company's smelting and refining plants. This expertise is essential to determining the correct quantities and types of raw materials to purchase for the most efficient processing.

A carload of concentrates is first sampled and tested for metal values before unloading.

In addition to outright purchases of ores and concentrates, Asarco processes the output of some independent mining companies on a toll basis. Under this arrangement the miner receives his metals back in a refined form and pays Asarco for the smelting and refining services. The ore department also handles such toll agreements.

Currently, Asarco purchases or tolls monthly for smelting and refining materials containing about 35,000 tons of copper in concentrates and ore, 20,000 tons of lead in concentrates, and about 15,000 tons of zinc in concentrates. These materials originate in mines, including Asarco's, spread across the United States, as well as in Canada, South America, Mexico, Central America, Australia, and the Philippines.

In addition to primary ores and concentrates, Asarco also purchases, or treats on toll, copper, lead, zinc, and precious metal scrap. In some cases the Company's Federated Metals Division acts as a purchasing agent for these secondary metals.

Also, being a refiner, Asarco buys blister copper from some foreign smelters, and lead and zinc from the United States Government stockpile for processing and casting into commercial forms. Additionally, the Company refines blister copper on a toll basis for other copper producers.

As a seller to other processing companies, the ore department markets copper concentrates from Asarco's Arizona mines when production temporarily exceeds available smelting capacity, from British Columbia (Granduc mine), and from Newfoundland (Buchans mine). Lead and zinc concentrates are sold from Newfoundland and Tennessee. Sales are made to smelters in all parts of the world depending on comparative freight costs, available capacity, and treatment charges at the time the contracts are entered into.

Asarco receives copper concentrates from abroad as well as from mines in the U.S.

Asarco the smelter-refiner

Virtually every major nonferrous mining company in the United States has at one time or another over the years used Asarco's smelting and refining services. And many small miners have relied almost entirely on Asarco to process their ores and concentrates. Four of the original 18 smelters and refineries which made up Asarco when it was organized are still in operation today: the Omaha, Nebraska, lead refinery; the Globe by-products plant at Denver, Colorado; and the East Helena, Montana, and El Paso, Texas, lead smelters.

COPPER

Asarco's largest volume of smelting and refining activity is in copper. Three smelters—at Tacoma, Washington; Hayden, Arizona; and El Paso, Texas—process copper ores and concentrates into blister copper. This product is then refined at the Perth Amboy, New Jersey; Baltimore, Maryland; or Tacoma refineries.

The Hayden plant always has been a custom smelter but, with the emergence of Asarco as a leading copper mining company in the Southwest, Hayden also treats output from the Company's Silver Bell, Mission, and San Xavier mines, and will process concentrates from Sacaton as well. Blister copper from Hayden is refined at all three of the Company's refineries.

Asarco's El Paso plant is the only smelting complex in the U.S. that produces lead and copper at the same location. The processes are carried on separately but use the same rail facilities and other services. Asarco smelts ores—both lead and copper—at El Paso which are high in by-product content. Many of these by-products are recovered later at either of the Company's two East Coast copper refineries, or at the Omaha lead refinery. In addition, zinc is recovered in oxide form at El Paso in a fuming operation which treats slag from the lead smelter. The zinc fume is shipped to Corpus Christi, Texas, where Asarco refines it and casts it into slab zinc or zinc alloys. El Paso's cadmium is contained in residues shipped to Globe.

The Tacoma plant was purchased by Asarco in 1905 as was the Selby, California, lead smelter and the Federal lead smelter in Alton, Illinois. The copper refinery at Tacoma was built in 1915 to treat the blister product of the smelter. Tacoma has always been an important facility for Asarco. Its West Coast tidewater location enables it to treat raw materials from Alaska, Canada, Central and South America, and the Philippines. Additionally, Tacoma is the only plant in the United States equipped to remove arsenic from arsenic-bearing copper ores and reclaim arsenic by-products from residues of other smelters. It is a major world producer of arsenic trioxide.

Asarco's two East Coast copper refineries process blister copper from El Paso and Hayden, as well as some purchased or toll blister and some copper scrap. Both facilities employ the electrolytic method for refining copper. This method allows efficient recovery of precious metals and other "impurities" in copper blister or scrap.

The Baltimore plant can trace its origin back to 1814 when Levi Hollingsworth built what was then called the Gunpowder Copper Works. Hollingsworth's plant was set up to treat ores from various Maryland mines, which also supplied Paul Revere's copper plant near Boston.

At Baltimore, Asarco has pioneered many important copper processing methods. Among these are the Peirce-Smith converter, the continuous casting of copper

Pouring slag at in Asarco smelter.

cakes and large billets, and the Asarco vertical shaft furnace, now the principal copper melting furnace used in the industry.

The Perth Amboy plant originally was built to smelt the ores of the Guggenheim mining interests in Mexico. For many years, it also housed Asarco's research laboratories.

Asarco is constructing a major new electrolytic copper refinery with a capacity of 420,000 tons per year at Amarillo, Texas. It is scheduled to start up in late 1975 to coincide with the planned phase-out and eventual closing of the Baltimore facility. The Amarillo plant will include a by-products facility capable of producing 60 million ounces of refined silver per year and substantial quantities of selenium, tellurium, nickel salts, and other by-products of copper refining.

ZINC

Asarco has been a major U.S. producer of zinc since 1915 when it operated two plants in Oklahoma. The natural gas fuel supply for these plants had begun to diminish by the early 1920's, however, so the Company found it desirable to build a new smelter at Amarillo,Texas, to take advantage of the availability of natural gas in the Texas Panhandle. Today, with natural gas again becoming scarce and the horizontal retort

(Opposite page) Copper starting sheets in acid bath at electrolytic refinery tank house. Copper from the anodes is deposited on starting sheets which are withdrawn as cathodes. "Impurities" such as gold, silver, selenium settle to bottom of tanks and are recovered later. (Above) Workers at Glover strap lead pigs for shipment. (Opposite) Refined zinc is stripped from aluminum cathodes following electrolytic deposition.

ASARCO SMELTING-REFINING HISTORY HIGHLIGHTS

1899—Asarco organized. Major plants in consolidation included: Globe (Denver, Colorado), Omaha (Nebraska), East Helena (Montana), El Paso lead plant (Texas), Arkansas Valley (Leadville, Colorado).

1900-1909—Perth Amboy plant acquired from Guggenheims.
Control of the Federal lead smelter in Alton, Illinois, acquired.
Selby, California, lead smelter purchased.
Tacoma, Washington, smelter purchased.
Garfield copper smelter in Utah built to process ore from the Bingham pit.
Baltimore copper refinery purchased.

1910-1919—Copper smelter built at El Paso plant.
Copper smelter constructed at Hayden, Arizona.
Copper refinery added to Tacoma plant.

1920-1929—Amarillo, Texas, zinc plant constructed.

1940-1949—Corpus Christi, Texas, zinc refinery constructed.

1950-1959—Federal lead smelter closed.
Garfield copper smelter sold to Kennecott Copper Corporation.

1960-1969—Arkansas Valley lead smelter closed.
Glover lead smelter-refinery started up.

1970-1975—Selby lead plant closed.
Purchased zinc oxide plants at Hillsboro, Illinois, and Columbus, Ohio.
Amarillo zinc refinery to be closed (1975).
Amarillo copper refinery under construction.
Baltimore copper refinery to be phased out (after 1975).

process for smelting zinc ores becoming obsolete, Amarillo is also slated to be closed. Asarco's major slab zinc production is obtained from a newer plant at Corpus Christi, Texas, which utilizes electrolytic methods of recovering zinc metal.

The Corpus Christi plant is really two plants in one. Half of the refinery is used for treating and refining zinc ores with high sulfide content. The other half is for production of zinc from oxide fume. The Corpus Christi sulfide plant was built in 1942, with the oxide department being added in 1953. Zinc solution from both of these operations is circulated continuously through electrolytic cells where the metal is deposited on aluminum cathodes. Both Special High Grade zinc slab and zinc die-casting alloys are produced at Corpus Christi, along with cadmium which is recovered before the zinc solution has passed through the electrolytic cells.

Asarco has purchased a 1400-acre site on the Ohio River near Stephensport, Kentucky, for possible construction of a 180,000 ton-per-year electrolytic zinc refinery. Feasibility studies were being conducted for this project in early 1974.

LEAD

Asarco smelts lead at East Helena, Montana, and Glover, Missouri, as well as at El Paso. Lead bullion from the smelters is refined at Glover and Omaha.

The Omaha lead plant was built in 1870 and became the Omaha and Grant Smelting Company in 1883. The Omaha plant is

the third largest lead refinery in the Western world. Omaha's strategic importance in the Asarco metallurgical complex is that it processes the lead bullion produced at both El Paso and East Helena. In addition, Omaha is the largest producer of bismuth in the United States and recovers valuable gold, silver, copper, tellurium, antimony, and tin values in the lead refining process.

The East Helena smelter is a service plant in the full sense of the word. It processes complex ores and concentrates from more than 50 small Montana mines as well as from mines throughout the western states, Canada, Australia, and South America. It ships to the Omaha refinery a bullion product that contains precious metal values and is high in bismuth content.

The East Helena plant has contributed much to the community and vice versa. Originally, one fourth of the financing for its construction in 1888 was raised by citizens of nearby Helena, Montana's state capital. Today the small community of East Helena is supported almost entirely by the smelter.

In 1972 Asarco purchased from The Anaconda Company a zinc fuming plant adjacent to the East Helena smelter to treat lead-smelter slag. It ships the zinc oxide fume product, first to El Paso for de-leading, and then to Corpus Christi for refining.

The Glover smelter-refinery in the Lead Belt of southeast Missouri was started up in 1968. Under a long-term contract, it is currently smelting and refining the mine production from Kennecott's Ozark mine. Since ores in Missouri are relatively free of impurities, the output from Glover is refined lead of very high quality. Small amounts of silver and copper are contained in the Glover feed, and these are recovered from residues shipped to other Asarco plants for processing.

The Globe plant at Denver, which originated as a lead smelter in 1866, is now one of Asarco's chief by-products facilities. Products which occur in relatively small quantities in the circuits of many other Asarco plants but which cannot be efficiently recovered by those plants individually are recovered at Globe. Cadmium is such a material; and Globe's production has made Asarco the largest world producer of that metal. In 1970 the Globe plant added a high-purity metals facility which produces metals—copper, lead, zinc, arsenic, antimony, etc.—of nearly 100% purity. These are used mainly in metallurgical research.

Copper wirebars awaiting shipment to customers.

Asarco the marketer

"From the earth . . . metals and minerals for a better life."

Asarco markets copper, zinc, lead, silver, and other metals and minerals to manufacturers who fabricate them into the necessities and luxuries which have become part of modern everyday life.

COPPER

Copper plays a vital role in making some of the wonders of modern technology possible and the comforts of modern life practical. Its ability to conduct electricity makes it essential for electric generators and motors, lighting fixtures and wiring, radio and TV sets, computers—in short, for everything electrical.

Its ability to conduct heat has made copper invaluable for automobile radiators, air conditioner tubing, home heating systems, steam condensers, to name a few. Its corrosion resistance and the ease with which it can be joined have made copper the choice for plumbing and piping systems, automotive fuel lines, sea-water desalting plants, hydraulic systems, and many more applications. Alloyed with zinc, it becomes brass; with tin, bronze; and finds its way into a myriad of decorative and functional uses. It's hard to imagine life as we know it without the "red metal", copper.

LEAD

Lead's principal use is in storage batteries for cars and trucks, boats, aircraft, and electric-powered vehicles such as golf carts and industrial fork-lift trucks. Lead in the form of anti-knock additives for gasoline also contributes to the smooth and economical operation of the modern automobile. Solder, paint pigments, cable sheathing, sound attenuation, and ammunition are other important uses for lead.

ZINC

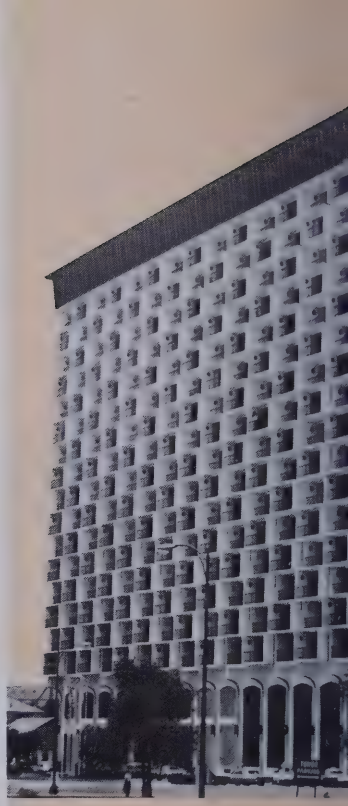
More than one third of the zinc consumed in the U.S. is used to protect steel from corrosion. Zinc coating, or galvanizing, extends the life of everything from steel bridges to watering cans. An equally important use of zinc is for die castings, many of which end up as the bright, chrome-plated fixtures on automobiles and appliances.

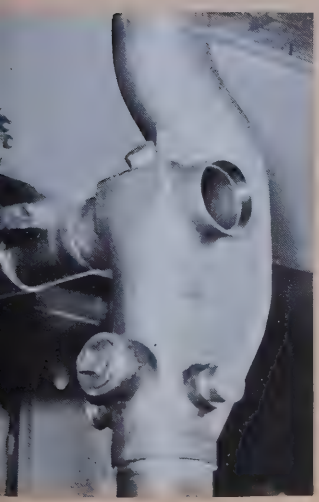
SILVER

Silver in the form of silver halide is the light-sensitive coating on film that makes photography possible. Silver metal is used widely in electrical and electronic components, in brazing alloys, in elegant tableware, and in coinage.

BY-PRODUCT METALS

Although produced by Asarco in much smaller quantities, the by-product metals are no less important. Antimony, for example, is used in flame-proofing compounds, bismuth in low-melting-point alloys, cadmium in portable batteries, selenium for decolorizing glass, and tellurium to improve the machinability of carbon steel.





(Clockwise from top left) Lead wool for caulking and lead sheet for soundproofing are part of modern hotels. Radiators for automobiles are made from copper while zinc also has many functional and decorative applications in cars. A water sprinkler protected by zinc from rusting. Copper is essential in diesel-electric motors and generators. Zinc die castings are strong, economical and attractive frames for portable radios. Copper is used for plumbing. A calcium-lead battery for standby telephone power.

Asarco's major products are commodities whose prices are influenced greatly by daily trading on the world's metal exchanges. As a custom smelter and refiner, Asarco buys from others in the form of ores, concentrates, and blister much of the metal that it sells. These purchases are made at prevailing prices less smelting and refining charges. An important part of the marketing function, therefore, is to sell at prevailing prices in the course of each pricing period an amount of metal equivalent to that purchased in order to avoid losses due to fluctuations in market prices.

Transporting the large tonnages of metal which Asarco sells also assumes great importance in the overall marketing operation. Asarco pays over $50 million per year in freight charges in moving raw materials to the plants and metals to consumers.

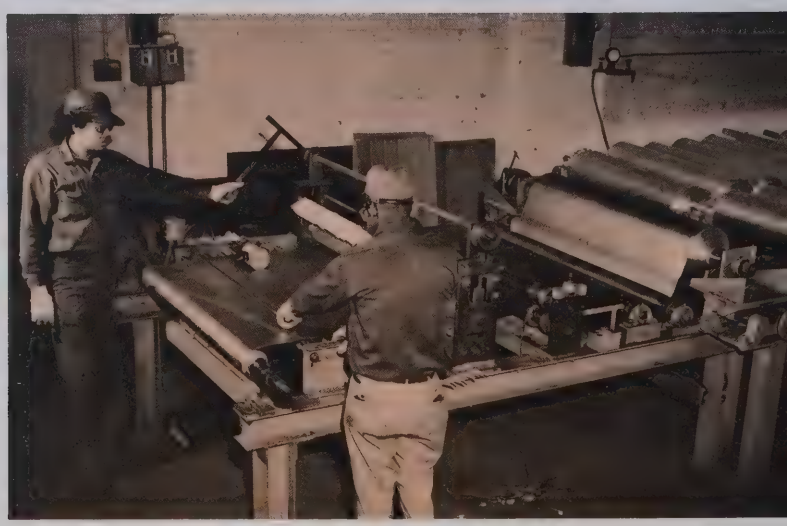
Shipment of cadmium balls being labeled for export (left).
Scrap metal awaiting recycling at a Federated Metals Division plant (right).

Asarco the recycler

Widespread concern for the environment and the desire to conserve natural resources have made the reuse of metals important in today's society. The Federated Metals Division of Asarco each year converts more than 100,000 tons of scrap metal into hundreds of useful products. In addition, Asarco's primary smelters and refineries handle many thousands of tons of scrap a year. Thus the Company is one of the world's largest nonferrous metal recyclers.

Coincidentally, the history of the Federated Metals Division parallels that of Asarco in that Federated originally was a consolidation of secondary metals companies brought together in 1924. Asarco purchased the resulting company in 1932. Subsequently, the name was changed from Federated Metals Corporation to the Federated Metals Division.

Today the Federated Metals Division comprises nine plants, four stock supply centers and 18 sales offices in the U.S. and Canada. Federated is the only nationwide secondary metals producer covering so broad a range of nonferrous alloys. The products of Federated serve such industries as automotive, chemical, construction, electronics, electroplating, machinery, primary metals, shipping (maritime), and public utilities.



(Left) Solder wire ready for shipment. (Below) Acoustilead® lead sheet for noise control being manufactured at a Federated plant.

Reclaiming scrap metals involves careful selection and sorting of the materials acquired from scrap dealers and metal fabricators. The largest sources of reclaimable nonferrous metals are used automobile and truck batteries, razed buildings and industrial plants, discarded automobiles and other metal goods. Also, metalworking plants generate thousands of tons of scrap yearly in the form of turnings, clippings, and other excess metal from cutting, stamping, grinding, and other fabricating processes.

Basically, there are two kinds of scrap: clean and segregated scrap which can be realloyed and used without refining, and mixed or contaminated scrap which must be completely reprocessed. Clean scrap generally is the by-product of a manufacturing process, whereas contaminated scrap is from metal products which have been discarded and collected by scrap dealers. The dealers sort the material and crush and compress certain types into shapes suitable for processing.

A typical Federated recycling operation is at the Newark, New Jersey, plant. Different kinds of scrap lead, white metal residues, discarded type metal, babbitt metal, and lead and solder drosses are melted down and converted into type metal, babbitt alloys, and various solder alloys. After refining in furnaces and kettles, the composition of the melt is adjusted after analysis to meet metallurgical specifications as rigid as those for primary metals. Then the molten metal is cast into various shapes in Asarco's Castomatic® machines, or is extruded into rods and wires.

On the marketing side, Federated employs its own sales force and also sells through distributors and manufacturers' representatives. Federated also markets the zinc die-casting alloys produced at Asarco's Corpus Christi refinery. Federated salesmen are trained to provide technical and problem-solving assistance to their customers, and are backed up by experienced metallurgists and the analytical and research facilities of Asarco's Central Research Laboratories.

With increasing emphasis on the recovery of reusable materials from municipal and industrial wastes, Federated's ability to convert the resulting scrap metals into refined metals and alloys on a large scale should take on increasing importance.

Asarco worldwide

Asarco has played a prominent role in the development of mineral deposits throughout the world. Since its inception, the Company has been involved in mining and smelting operations in Mexico; and over the years it has expanded across oceans and continents to such countries as Australia, Peru, Canada, Nicaragua, and Saudi Arabia. Today, Asarco's major foreign investments are in: M.I.M. Holdings Limited in Australia; Southern Peru Copper Corporation; Asarco Mexicana, S.A.; Neptune Mining Company in Nicaragua; and Granduc in British Columbia, Canada.

M.I.M. Holdings Limited

M.I.M. Holdings Limited (MIM) is 49% owned by Asarco and is the parent company of Mount Isa Mines Ltd. of Queensland, Australia. Although the Mount Isa property today is the largest nonferrous metal producer in Australia, it achieved this distinction only after years of difficult development work, unremunerative metal prices, and heavy financial burdens.

The Mount Isa story started in 1923 with the discovery of a silver-lead deposit. Its development, however, was handicapped until 1930 when Asarco provided some badly needed financing. This involved the purchase by Asarco of a substantial holding in what was then called Mining Trust Ltd., an organization formed in 1929 which held a majority interest in Mount Isa. With the financial assistance of Asarco construction programs were completed at Mt. Isa and mining, milling, and smelting operations got underway in 1931.

Asarco's faith in the long-term future of the Mt. Isa project caused it to retain its interest during a long initial period of unprofitability. The first dividend was paid in 1947 — 24 years after the discovery of the ore deposit at Mt. Isa. Asarco's financial and technical aid kept the project alive during this period and enabled Mt. Isa to provide employment for Australians during the world economic depression of the 1930's as well as supplying Australia with valuable metals during the Second World War.

A copper ore body was found near the silver-lead veins, and during World War II the Australian government asked the company to concentrate on producing copper for the war effort and to suspend output of lead, zinc, and silver. Mt. Isa resumed full-scale lead, zinc, and silver production following the war.

Today Mt. Isa has a capacity to produce annually more than 170,000 tons of copper, 12 million troy ounces of silver, more than 160,000 tons of lead, and well over 100,000 tons of zinc contained in concen-

Mt. Isa complex in Australia (left). (Right) Inside Southern Peru's Ilo smelter.

trates. Another major ore body, the Hilton mine, is being developed by Mt. Isa. It is located about 15 miles north of the town of Mt. Isa, and contains a substantial deposit of lead-zinc-silver ore.

In addition to Mount Isa Mines Limited, MIM operates Copper Refineries Pty, Ltd. at Townsville, Queensland; the Britannia Lead Company, which has a lead-silver refinery at Northfleet, England; and Bowen Consolidated Coal Mines Limited of Queensland. Other interests of MIM in Australia are a 25% share in McCamey Iron Associates, which holds concessions on iron ore deposits in Western Australia; and an approximately 17% interest in Thiess Holdings Limited, which has large coal reserves in Queensland.

Southern Peru Copper Corporation

Southern Peru Copper Corporation was formed in 1952 and now is jointly owned by four U. S. mining companies (Asarco, Phelps Dodge Corporation, Cerro Corporation, and Newmont Mining Corporation) with Asarco holding a 51.5% interest. Southern Peru is one of the world's most important producers of copper, and is currently producing nearly 150,000 tons of blister copper annually.

Southern Peru operates an open-pit mine and concentrating mill high in the Andes Mountains at Toquepala, and a smelter at Ilo on the Pacific Coast 60 air miles from the mine, but 110 miles by rail. Production at the mine and smelter began in 1960.

At the heart of Southern Peru's success is the combined expertise of the investing companies. The mineral potentialities of the ore bodies were revealed by the exploration work of engineers and geologists of Asarco, Cerro and Newmont. Stripping and mining methods developed at Phelps Dodge's open-pit copper mines in the U.S. provided patterns for open-pit planning in Peru. Modern design and construction features which Newmont built into its San Manuel, Arizona, copper complex received further application in the Toquepala mill and Ilo smelter. Additionally, the suspended arch reverberatory furnace, first used in the U. S. by Asarco, and the casting wheel designed by Asarco's Western Engineering Group are indicative of the many technical contributions of the participating companies.

A little further inland from Toquepala is the Cuajone ore body which Southern Peru is currently developing. Cuajone has estimated reserves of about 468 million tons of sulfide ore averaging slightly over 1% copper, and is expected to be brought into production in the mid-1970's.

Asarco Mexicana, S.A.

In Mexico, Asarco has its longest and probably most interesting foreign mining history. One of the principal properties that made up the original Asarco consolidation in 1899 was the Santa Eulalia lead-silver mine in Mexico which is still operating. With acquisition of certain Guggenheim interests in 1901 came other Mexican properties.

Asarco Mexicana, S.A., was organized in 1965 when Asarco sold a 51% interest in its Mexican mines and plants to Mexican industrialists to comply with Mexican law and to become eligible for tax benefits available to Mexicanized companies. Asarco Mexicana now operates eight mines and four smelters and refineries. It is the largest silver and zinc producer in Mexico, and a leading producer of copper, lead, and coal. Asarco supplies certain technical services to Asarco Mexicana and under contract handles the sale of refined metals outside Mexico.

A night view (above) of Southern Peru's giant Toquepala Mine. (Below) The mill and surrounding facilities at Granduc in British Columbia.

Asarco world map

MAIN OFFICE — ASARCO
New York, New York

MAIN OFFICES — ASSOCIATED COMPANIES
Brisbane, Australia
Lima, Peru
Mexico, D.F., Mexico

★ ADMINISTRATIVE OFFICES
Knoxville, Tennessee
Salt Lake City, Utah
Tucson, Arizona
Wallace, Idaho

▲ CENTRAL RESEARCH LABORATORIES
South Plainfield, New Jersey

● SMELTERS AND REFINERIES

Copper
Amarillo, Texas (Refinery)*
Baltimore, Maryland (Refinery)
El Paso, Texas (Smelter)
Hayden, Arizona (Smelter)
Perth Amboy, New Jersey (Refinery)
Tacoma, Washington (Smelter, Refinery)

Zinc
Amarillo, Texas (Retort Plant)
Columbus, Ohio (Zinc Oxide)
Corpus Christi, Texas (Electrolytic Plant)
East Helena, Montana (Slag Fuming Plant)
El Paso, Texas (Slag Fuming Plant)
Hillsboro, Illinois (Zinc Oxide)

Lead
East Helena, Montana (Smelter)
El Paso, Texas (Smelter)
Glover, Missouri (Smelter, Refinery)
Omaha, Nebraska (Refinery)

Cadmium, High-Purity Metals
Denver, Colorado (Refinery)

■ OPERATING MINING PROPERTIES

Buchans (Zinc, Lead, Copper, Silver)
Buchans, Newfoundland, Canada
Galena (Silver, Copper)
Wallace, Idaho
Granduc (Copper)
Stewart, British Columbia, Canada
Ground Hog (Zinc, Lead, Silver)
Vanadium, New Mexico
Manchester (Ilmenite)
Manchester Township, New Jersey
Lake Asbestos of Quebec, Ltd. (Asbestos)
Black Lake, Quebec, Canada
Leadville (Zinc, Lead, Silver)
Leadville, Colorado
Midland Coal Company
Allendale (Coal) Wyoming, Illinois
Edwards (Coal) Edwards, Illinois
Elm (Coal) Trivoli, Illinois
Mecco (Coal) Victoria, Illinois
Mission (Copper, Silver, Molybdenum, Zinc)
Sahuarita, Arizona
Northern Peru Mining Corporation
Quiruvilca (Copper, Zinc, Lead, Silver)
Quiruvilca, Peru
Sacaton (Copper) Casa Grande, Arizona
San Xavier (Copper) Sahuarita, Arizona
Silver Bell (Copper, Molybdenum, Silver)
Silver Bell, Arizona

*Under Construction

Tennessee Mines Division
American Limestone (Sand, Gravel, Limestone) Knoxville, Tenn.
Coy (Zinc) Jefferson County, Tenn.
Immel (Zinc) Knox County, Tenn.
Mascot (Zinc) Mascot, Tenn.
New Market (Zinc) Jefferson County, Tenn.
Young (Zinc) Jefferson County, Tenn.

◆ FEDERATED METALS DIVISION

(Acoustilead, additives and hardeners, aluminum alloys, babbitt, brass, brazing alloys, bronze, cathodic protection products, continuous cast bronze rod and tube, fusible alloys, jewel metal, lead products, nickel salts, plating anodes, solder, type metal, zinc dust, zinc oxide)
Houston, Texas
Newark, New Jersey
Perth Amboy, New Jersey
San Francisco, California
Sand Springs, Oklahoma
Somerville, New Jersey
Trenton, New Jersey
Whiting, Indiana

Asarcon Federal Products Division
Somerville, New Jersey (Bronze bearings, bushings and parts)

Lone Star Lead Construction Corp.
Houston, Texas (Lead burning)

Federated Genco, Ltd.
(Solder, type metal, babbitt, lead products, lead construction)
Burlington, Ontario, Canada
Montreal, Quebec, Canada
Toronto, Ontario, Canada

◇ METAL FINISHING PLANTS

Enthone, Incorporated
Chicago, Illinois (Metal finishing chemicals)
Cleveland, Ohio (Plating chemicals)
Toronto, Canada (Metal finishing chemicals)
West Haven, Connecticut (Metal finishing chemicals)

Ionic International Inc.
Warren, Michigan (Automatic plating equipment)

ASSOCIATED MINING COMPANIES

□ Mine ○ Smelter or Refinery

Asarco Mexicana, S.A. (Zinc, Lead, Silver, Gold, Copper, Coal, Coke, Fluorspar)
Mexico, D.F., Mexico
M.I.M. Holdings Limited
Mount Isa, (Copper, Lead, Silver, Zinc)
Queensland, Australia
Hilton* (Lead, Silver, Zinc)
Queensland, Australia
Bowen Consolidated Coal Mines (Coal)
Bowen, Queensland, Australia
Britannia Lead Company Limited (Lead Refinery) Northfleet, Kent, England
Copper Refineries Pty, Ltd.
Townsville, Queensland, Australia
Neptune Mining Company (Zinc, Lead, Gold, Silver)
Bonanza, Nicaragua
Southern Peru Copper Corporation (Copper, Molybdenum)
Cuajone*, Peru
Toquepala, Peru

Opposite page: (top) Loading coal. (bottom left) Printed circuit board plated using Enthone chemicals. (bottom right) Dredging overburden from asbestos deposit during development at Black Lake, Quebec, Canada.

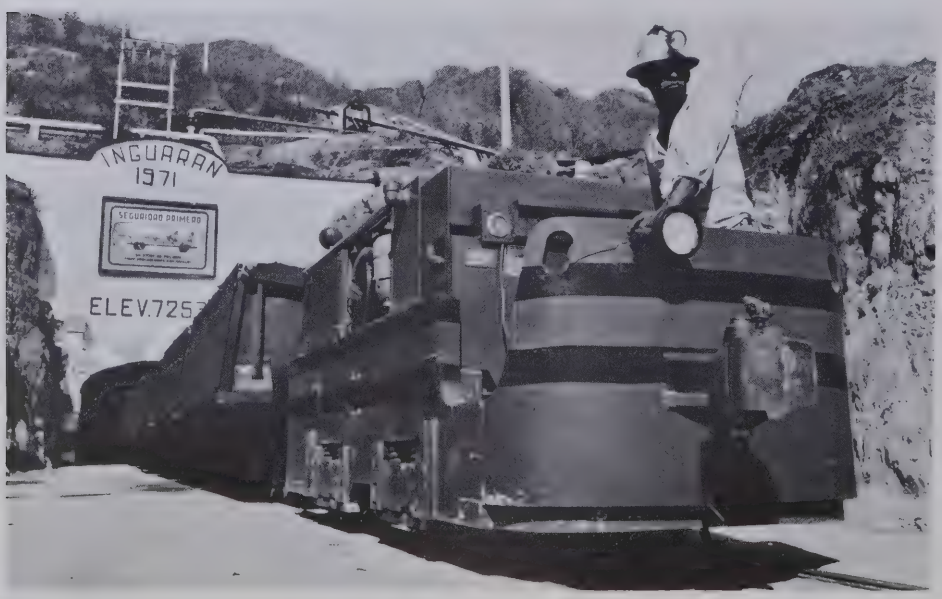
Neptune Mining Company

Neptune Mining Company in Nicaragua, 51.8% owned by Asarco, began as a gold producer in 1938; however, high-grade gold ore reserves have been depleted, and today the property is primarily a lead-zinc producer. These metals are mined at Neptune's new Vesubio mine, which started up in 1971. Substantial low-grade gold ore reserves still exist at Neptune's holdings in Nicaragua and will continue to be mined if the international gold price stabilizes at a high level.

Granduc

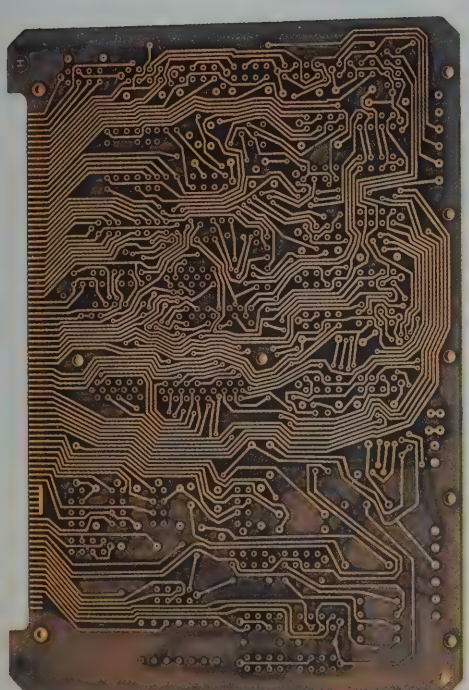
In Canada, Asarco owns a 50% interest in the Granduc copper mine. Newmont Mining Corporation, the other partner, manages the mine. Development of Granduc, located in northern British Columbia near the Alaskan border, represents man's triumph over some of the severest obstacles nature has ever placed in the path of mineral discovery and mine development. The ore body is partially covered by a glacier; an 11-mile tunnel had to be driven under three mountain ranges for transportation of workers, ore, and supplies; and annual snowfall can amount to over 100 feet. Granduc began copper production in late 1970 on a limited basis and by the end of 1973 was producing 8,000 tons of ore per day. Newmont and Asarco each markets its share of the mine's annual production, currently about 34,000 tons of copper in concentrates.

That Asarco's five major foreign investments mentioned above are significant in international mining is shown by the production figures. The average annual output of the five for the three years 1971 thru 1973 was 325,500 tons of copper; 219,100 tons of lead; 245,500 tons of zinc; and 25,200,000 troy ounces of silver.



Inguaran, Asarco Mexicana's newest copper mine.

ASARCO'S EXPANDING INTERESTS



Asarco management seeks to broaden and diversify the Company—but only in fields where its expertise in mining and mineral processing can be put to good use. For example, in recent years it has ventured into coal, asbestos, limestone, ilmenite, and specialty chemicals used in metal finishing.

ASBESTOS

Asarco's entry into nonmetallic mining began in 1952 with the formation of Lake Asbestos of Quebec Ltd., which was organized to develop and operate the Black Lake mining property in Quebec, Canada, held by United Asbestos Corporation. In order to gain access to the asbestos deposit an entire lake had to be dredged and drained. More than 40-million cubic yards of earth and rock had to be removed. After overcoming these obstacles, the company began asbestos production in 1958 and is now producing about 120,000 tons of fiber annually at Black Lake.

The Black Lake deposit contains 3% to 4% asbestos of high quality. The ore is concentrated first by magnetic separation and then milled to recover the asbestos fiber.

In 1973, a nearby mine and mill, previously operated by National Asbestos Mines, Limited, was acquired, expanding production of short fibre asbestos.

Asbestos is best known as a heat-resistant substance. Because of its great tensile strength, it is also used today as a primary reinforcing agent in asbestos-cement pipe and sheet, in plastics, and in floor tile. Lake Asbestos today accounts for about 12% of the total Canadian production of asbestos. Sales are made in markets throughout the world.

COAL

Asarco's Midland Coal Company division is an important supplier of coal to electric utilities and industrial customers in the midwestern states. It operates four bituminous coal mines in Illinois which were acquired from Peabody Coal Company in 1970.

Midland produces about four million tons of coal annually by strip mining methods. Huge draglines and shovels first remove from sixty to eighty feet of earth to uncover the coal seam. The coal is scooped out with electric shovels and loaded into trucks for transporting to a preparation plant where it is crushed, cleaned by washing away the clay and shale, dried, and then shipped to market. The mined area is reclaimed by grading and the planting of forage, trees and shrubs. Reclamation of farm land includes additional procedures to return the land to a condition suitable for restoration to farming.

American Limestone produces railroad ballast, concrete aggregate, sand, and crushed rock from zinc mine tailings and waste (below) Ilmenite-bearing slurry from dredge spirals through concentrators at Manchester mill to separate titanium dioxide mineral from lighter sand (right).

STONE

The American Limestone Company was purchased, along with the Tennessee zinc mines, from The American Zinc Company in 1971. The zinc ore in eastern Tennessee occurs with limestone, and American Limestone was formed originally to process the tailings and waste from the zinc mines into agricultural limestone, building stone, crushed rock, sand, and gravel. Demand for these products eventually exceeded the supply available as a by-product of zinc mining, however, and American Limestone expanded into quarrying of stone and dredging of sand and gravel. Subsequently, the company expanded further into the ready-mix concrete business.

ILMENITE

Asarco's Manchester ilmenite mine, located near Toms River, New Jersey, started up in 1973. It will supply 165,000 long tons per year of ilmenite concentrates to E. I. du Pont de Nemours and Company under a 10-year contract. The concentrates contain about 63% titanium dioxide, a white pigment used in paints, plastics, and other products.

The ore, containing about four percent titanium dioxide mineral, is mined by a suction dredge operating in a moving lake. The lake moves forward as the dredge advances and is filled in behind the dredge with clean sand returned from the concentrating plant. Covering the sand with previously removed top soil and planting of grass and other vegetation restores mined areas as nearly as practicable to their original state.

PLATING CHEMICALS

The Federated Metals Division of Asarco has had a substantial interest in plating as a manufacturer of copper, zinc, and cadmium anodes for electroplating. Enthone Inc., a manufacturer of specialty chemicals for electroplating and metal finishing, was purchased in 1957. Enthone was founded in 1930 and has plants in West Haven, Connecticut, and Chicago, Illinois. Its products are manufactured and sold throughout the Free World by affiliated companies and licensees.

ASARCO THE ENVIRONMENTALIST

The mining and smelting of ores to produce the metals needed by society inevitably disturb the environment to some degree. The earth's surface must be penetrated, rock must be crushed, metallic compounds must be concentrated, and waste material must be disposed of. The smelting of ores and concentrates to free the contained metals from their chemical bonds to sulfur produces large quantities of sulfur dioxide. High temperatures and swiftly-moving streams of process air generate metal oxide fumes and dusts which can create formidable environmental problems. But long before such problems became matters of general public concern, Asarco was working to solve them.

In 1911 at its Perth Amboy plant, Asarco installed one of the first units in the nation to capture smelter sulfur dioxide and convert it into sulfuric acid. An improved acid production process was utilized in 1916 at the Company's Garfield, Utah, smelter. The first electrostatic precipitator, a device developed by Frederick Gardner Cottrell to clean dust-laden gas streams, was installed at Asarco's Selby, California, lead smelter in 1907. Not long afterward techniques were employed to filter particles from gases in "baghouses" containing hundreds of hanging woolen bags.

By 1914 the Company had established in Salt Lake City a laboratory, later known as the Department of Agricultural Research, exclusively devoted to study of the effects of smelter emissions and to develop means of better control. In the years since, the laboratory's scientists have made many contributions to the scientific literature, especially on the subject of SO_2 and its effects on vegetation. The first successful automatic instrument for detecting and recording traces of SO_2 in ambient air was invented by Asarco's Dr. M. D. Thomas in 1928. The Thomas Autometer, as it is called, has been widely used in studies of urban air pollution.

In recent years when air quality standards for SO_2 were adopted by federal, state, and local air pollution control agencies, Asarco responded by developing a "closed-loop" system to meet the standards. Briefly, the system consists of outlying SO_2 monitoring instruments connected by telephone lines to a control center in the smelter. When SO_2 in the ambient air has an upward trend likely to exceed standards, professional meteorologists at the center order whatever degree of smelting curtailment is necessary to reverse the trend. Local and regional weather data and computers are also used by the meteorologists to predict conditions unfavorable to SO_2 dispersion so that curtailment can be ordered in advance of any SO_2 accumulation. Successful applications of closed-loop or intermittent control systems have been demonstrated at Asarco's El Paso, Tacoma, and Glover smelters.

Properly designed tall stacks are important to environmental control programs for smelters. No SO_2 abatement short of perfection would be adequate if smelter gases were discharged near ground level. Again Asarco pioneered by conducting scientific studies at Garfield, Selby, and Tacoma to evaluate and prove the effectiveness of tall stacks for dilution and dispersion of SO_2. Beyond their value as dispersion devices, stacks conserve energy by utilizing unrecoverable waste heat to

(Top left) Electrostatic precipitator for removing solid lead particles from smelter gases. (Top right) Asarco's electric car—a possible way to reduce air pollution. (Center) Reclaimed land at Asarco's Midland Coal Company. (Bottom left) A tree is planted on tailings dump at the Mission Mine. (Bottom right) Monitoring air quality at an Asarco smelter.

provide draft for smelting processes and air-cleaning devices.

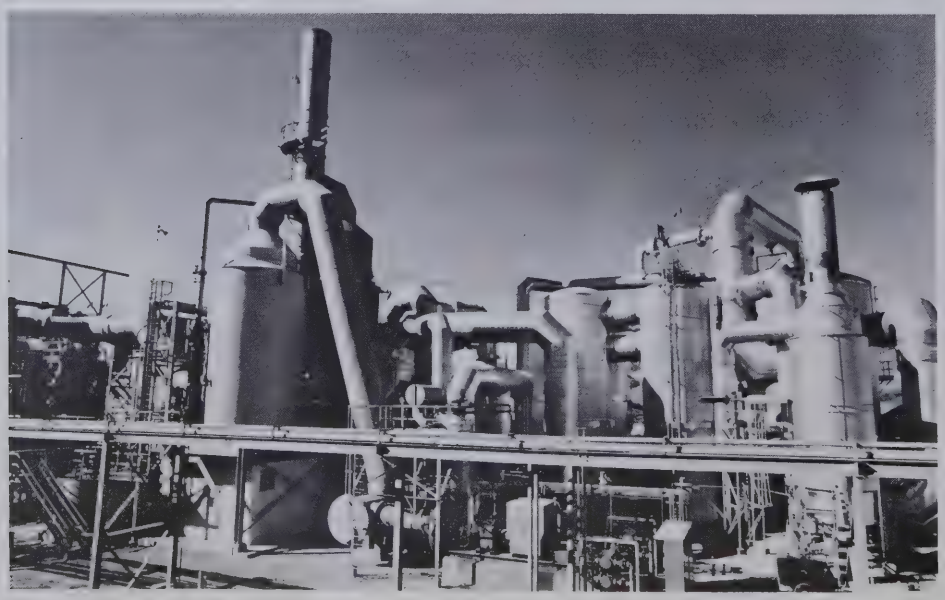
In addition, Asarco removes sulfur dioxide from smelter gases and converts it into sulfuric acid. Acid plants are in operation at the Company's three copper smelters, as well as at the zinc refinery at Corpus Christi and the Company's Columbus, Ohio, zinc oxide plant. Also, another facility at the Tacoma copper smelter produces liquid sulfur dioxide from smelter emissions.

Water quality control likewise receives a great deal of attention at Asarco's plants and mines. For example, facilities have been installed at Corpus Christi to collect and treat effluents from operations as well as rain water drainoffs. The treated water is partially reused by the plant.

In the area of land use, the mining industry has taken more than its share of criticism from civic and governmental groups in recent years. What many fail to take into account, however, is that since 1776 the total land area mined in the United States has amounted to only 0.3% and from this small portion of the land have come the metals and minerals which have built the nation. Moreover, of this 0.3%, one-third has been reclaimed. An example of Asarco's land reclamation is at the Company's Midland Coal strip mining operations in Illinois. There Asarco is reclaiming mined land by grading banks and planting forage, trees, and shrubs.

In-plant environmental quality control (safety) is another area to which Asarco devotes much effort. The Company's safety officials regularly inspect each plant and mine and offer specific programs for improvement.

Asarco's policy is based on the belief that a healthy environment and society's need for minerals and metals are compatible. Environmental impact can't be totally eliminated, but it can be controlled at safe levels. The Company is pledged to do what is required to insure that its operations do not endanger the health and welfare of its workers or its neighbors.



El Paso's sulfuric acid plant, dedicated in 1973 (left). Research work (right) at the elemental sulfur pilot plant at El Paso.

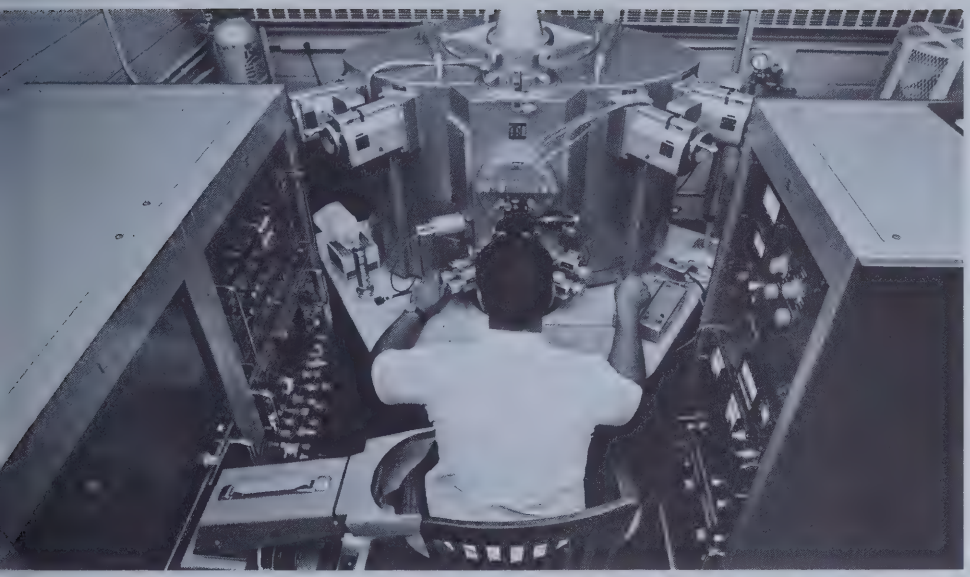
ASARCO THE RESEARCHER

One of Asarco research's most important contributions to the copper industry—the vertical shaft melting furnace (below). Electron-beam microprobe (right) used for mineral analysis.

Extracting and processing ores into metals requires complicated steps utilizing skills and technology developed over many years. The research department has contributed significant technological developments to the growth and success of Asarco's operations. Research activities are related to nearly every phase of the Company's business—from exploration through the marketing of the end products.

Asarco's efforts in both basic and applied research and technical service are directed toward improved methods for discovery and evaluation of potential ore bodies; improved methods for recovering metals and minerals from ore; more efficient metallurgical processes for all phases of smelting and refining; development of new products; aiding customers with specific problems; and surveillance of product quality. In recent years, environmentally-oriented research programs have been intensified to develop methods to control smelter emissions and water and noise pollution more effectively.

Asarco's research activities were centralized in 1925 when the Central Research Laboratories were organized at the Perth Amboy plant. Central Research was moved and expanded in 1952 in a large new laboratory located on a 27-acre plot in South Plainfield, New Jersey. This facility has the latest instruments and equipment for conducting metallurgical research. Scientists representing a broad spectrum of mineral sciences, chemistry, metallurgy and engineering work together on problems which demand a multi-faceted solution. As a result, Asarco today is a leader in nonferrous research and has gained recognition for



contributions to science and technology in this field.

To cite a few examples: the Asarco shaft furnace for continuous melting of copper cathodes has been adopted by practically all major copper refineries in the world; a process to control the lead content of refined zinc produced by electrolysis made commercial production of Special High Grade zinc feasible; a vacuum dezincing process is an important step in the refining of lead; and a new technique for recovering asbestos from ore made the processing of lower-grade asbestos ore practical.

The successful recovery of by-product metals is due in part to techniques developed by Asarco research. The recovery of bismuth during lead refining was made practical by the Betterton-Kroll process, first used commercially at the Omaha plant about 1929. Asarco's research efforts have also contributed to the recovery of antimony, selenium, tellurium, germanium, and other metals present in minute proportions in nonferrous metal ores.

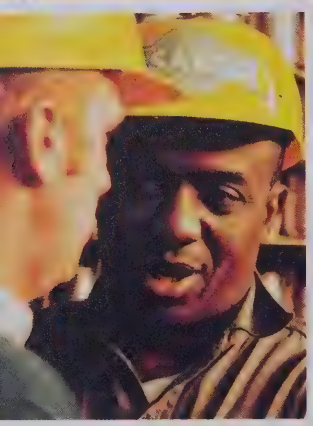
Development of new products to broaden Asarco's marketing potential is of major concern in the research department. Some achievements are a white brass die-casting alloy named Bronwite®; continuous cast calcium-lead alloy sheet for rechargeable batteries; and Asarco's Acoustilead® continuous cast lead sheet to reduce industrial noise levels.

The control of sulfur dioxide emissions from smelters has long occupied the attention of Asarco researchers. For example, in the 1930's Asarco engineers developed a method of absorbing and concentrating SO_2 from weak smelter gases with dimethylaniline. This process is used in the liquid SO_2 plant scheduled to start up in 1974 to help control emissions from the Tacoma smelter and has achieved limited use by other copper firms as well. More recently, Asarco has developed a process to convert SO_2 in smelter gases into elemental sulfur. A pilot plant co-sponsored by Asarco and Phelps Dodge Corporation was built in 1971 to investigate the commercial feasibility of this process.

Asarco actively supports several group research and technical programs. Included are programs of industry-wide organizations such as the International Lead-Zinc Research Organization, International Copper Research Association, Selenium-Tellurium Development Committee, the Silver Institute, the Smelter Control Research Association, and the American Society for Testing Materials. This is supplemented by individual participation of Asarco researchers in many professional societies related to their specific fields of interest.

Through the achievement of higher quality and improved efficiency in producing Asarco's products, Asarco research benefits consumers of nonferrous metal goods.


ASARCO



ASARCO THE EMPLOYER

Asarco's philosophy of employee relations is perhaps best expressed in the following excerpt from a pamphlet written in 1924 describing the Company's Group Life Insurance Plan:

"Cooperation is necessary for the well-being both of the Company and the men and women who work for it, and cooperation of employer and employee means loyalty on both sides; it cannot be one-sided. We believe that a large portion of those who work for the Company are loyal to it and we act upon that assumption. Let us continue to strive for common aims; the success of the Company and the well-being of those who do the work."

Concern for the well-being of its employees prompted Asarco to establish a group life insurance program as early as 1912, and a pension plan as early as 1909. Asarco was among the pioneers in both fields. Now, besides Company-funded pension, disability, and life insurance programs, Asarco offers a non-contributory medical plan; a tuition-refund plan to help salaried employees advance their education; supervisory and management development programs; and numerous on-the-job training and apprenticeship programs to enable workers to increase their skills and advance in their jobs. These programs and other employee benefits have been constructively worked out with employee representatives over the years.

Additionally, Asarco makes every effort to remain competitive in the areas of salaries and wages, job security, bonuses, and sound personnel practices generally. Asarco maintains close relations with educational institutions through its Technical Employment Department and other Industrial Relations Department activities.

Asarco has a long-standing policy that its employment practices shall provide equal opportunity for all employees without regard to race, color, creed, sex or national origin. Hiring practices, promotions and transfers at all levels of employment are based on an individual's qualifications and ability to perform the job requirements satisfactorily with due regard to seniority, while furthering the principles of Equal Employment Opportunity.

Recognizing the occupational hazards that exist in mining, smelting, and refining, Asarco in 1914 was one of the first major corporations to adopt the practice of having monthly reports on the number of disabling accidents per million man-hours of labor. This number, known as the Accident Frequency Rate, dropped from 233 for the entire Company in 1914 to 64 by the end of the first ten years of the program, and was 19 in 1973. In 1934 an Accident Severity Rate was established which measures the number of days lost per thousand man-hours of labor due to disabling accidents. Plaques are awarded each year in several different categories of plants to the Asarco units having the lowest Accident Frequency Rates and Accident Severity Rates, and competition for these awards is keen. Operating management works closely in cooperation with employee representatives in promoting a safe and healthful work environment.

An employee health program is conducted by Asarco's Environmental Sciences and Medical Departments. Biological monitoring through routine blood and urine tests protects the health of employees, particularly those exposed to potentially hazardous substances such as lead and arsenic. Regular health surveys are made at all plants and include inspection of bathing, ventilation, and sanitation facilities. Medical facilities are monitored and coordinated to ensure employee well-being.

Attesting to Asarco's concern for its employees are the more than 3,700 members of the Company's 25-year Club.

ASARCO AND THE FUTURE

The world will never outgrow its need for metals and minerals. Together with petroleum, agricultural produce, fish, and other products which come from the earth and the sea, they constitute the basic raw materials from which all material things derive.

Asarco views its business as the mining, smelting and refining of nonferrous metals and the production of other raw materials which utilizes similar technology. As the world's population increases and as the developing nations increase their standard of living, the demand for metals and minerals will continue to grow.

Asarco will continue to expand to meet this growing demand so that it will be in the future, as it is today, one of the world's most important suppliers of the range of elements it now produces. Additionally, just as Asarco's expertise in the production of nonferrous metals has been successfully applied to the extraction of coal, asbestos, and, most recently, titanium-bearing ilmenite, so the Company will continue to be alert to other areas where this expertise can be utilized to advantage.

There has been much concern recently about the possibility that the world will run out of some metals by the end of this century. Yet in 1971 the amount of copper contained in ore reserves in the U.S. was three times greater than it had been in 1950 despite the fact that in the interim the tonnage of copper mined equaled that contained in known ore reserves in 1950.

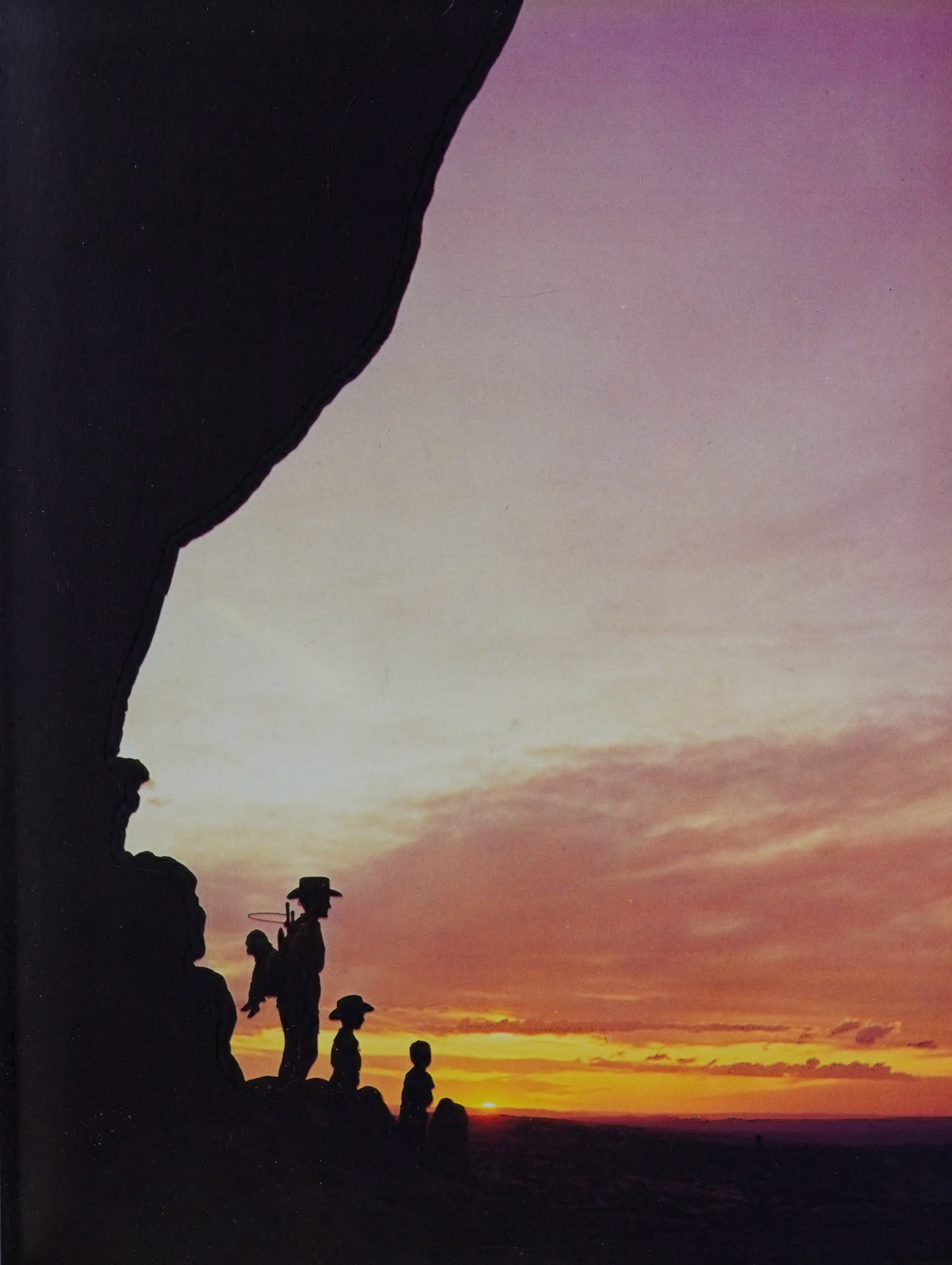
The key, of course, is exploration for new deposits and improving technology to make feasible the mining of lower-grade deposits. Asarco has important ore reserves and an ongoing exploration program to find more reserves to replace those which are mined. Increased recycling of metals will likewise help to supply the world's needs, and in this area Asarco's Federated Metals Division is ready to play an increasingly important role.

Mining a greater share of the material which it smelts and refines is another important goal of Asarco. Once known primarily as the world's greatest custom smelter, Asarco has steadily increased the proportion of material processed in its plants which comes from its own mines and those of its associated companies abroad.

The associated companies in Australia, Mexico, and Peru also have substantial ore reserves and programs of mine development to increase output from these reserves. While nationalistic sentiments have resulted in restrictions on the operations of foreign corporations in many developing countries, Asarco's management believes that by being responsive to the political, economic, and social objectives of the countries where it has investments, a modus operandi will continue to exist which meets the requirements of both the host country and Asarco.

Finally, as has its past, Asarco's future will rest on its smelting and refining capabilities, among the most diversified and metallurgically sophisticated in the industry. In order to keep them so, the Company has embarked on a major expansion and renewal program highlighted by the 420,000 ton-per-year Amarillo copper refinery. When the program is completed in the mid-70's, Asarco will have a modern smelting and refining complex incorporating the latest technology and meeting sound standards of environmental quality.

Asarco the Metal Maker will continue providing vitally needed metals and minerals to the nation and the world in the years to come.



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